MODERN EDUCATIONAL TECHNOLOGIES IN TRAINING SPECIALISTS AND BACHELORS IN ENERGY & POWER ENGINEERING

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ABSTRACT

The article describes the experience of the Elabuga Institute of the Kazan Federal University, one of the oldest Tatarstan higher educational institutions, in training teachers of physics, mathematics, computer science, and bachelors in energy & power engineering at the Mathematics and Natural Sciences Faculty. The specific character of activity of teachers who participate in training programs is described, those teachers who will have to work at technical colleges, vocational schools, at enterprises of the Alabuga Special Economic Zone, and research, development, and production and educational clusters.

The research methodology addresses the system approach, the universal connection of phenomena and processes of reality, and the education development sphere in the Russian Federation that is presented in the activity of the KFU and its structural units. The following research methods are selected: generalization of best practices, observation of students’ activity, analysis of scientific publications, learning and teaching publications, periodicals, Internet resources, the plans of study, working programs, organization of experiments and laboratory sessions, implementation of research projects in energy & power engineering, as well as implementation of innovative and digital technologies and teaching techniques.

Keywords: bachelors in energy and power engineering, masters, the education and science sphere, innovations, digital technologies, Alabuga.


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1. INTRODUCTION

Throughout Russia's history, the country's strength was in its inner territories (which were called "governorates" before). The territories were rich in natural resources, language, culture, and traditions of Russia's multi-nation people. The Republic of Tatarstan is one of such territories having the population of more than 3 million people. In the latest years, Tatarstan has demonstrated its potential and produced great results in the economic, scientific and technical, political, power, and educational (social) spheres of its development. The indicators of the Republic’s development in such areas as agriculture and interaction with various regions of the Russian Federation regarding trade, economic, and social collaboration are improving annually, while the relations with foreign countries in the sphere of education, power and electrical power engineering, power industry, and the professional personnel training system are becoming firmly established. It is in these spheres that traditions and innovations play their most important and crucial role [1].

Russian and foreign scientists have noted that education and the personnel training system can be used to manage the society’s reserves arrange the transfer of technologies from science and education to production and back, which leads to improvement of the society’s economic and social life [2, 3].

Federal universities play an important role in this process as it is there that reserves of further prosperity of Russia and its regions are concentrated, and universities’ activity improves the situation in science, education, industry, agriculture, and power industry, while the transition to digital technologies and their mass implementation provide vast possibilities for creative development of each person as the main participants in innovation processes.

Unfortunately, the phenomenon of training bachelors in energy & power engineering at humanities universities and institutes has not been properly studied by Russian and foreign researchers. This is a certain gap in knowledge related to the system of university (higher professional) education, as well as to the system of secondary professional, school, and out-of-school education, the activity of teachers and instructors, the experience of training and advanced training of professional personnel, and other areas of the society’s development.

It is important to trace the dynamics of change in activity of the higher educational institutions that are a part of federal universities, in particular, the Elabuga Institute of the Kazan Federal University (EI of the KFU) taking into account their historical and technological experience, to obtain a clear idea of the project to transform the model of university education, one of its goals being to implement the requests of the Fourth Industrial Revolution that includes such areas as science, education, innovations, and active implementation of digital technologies in all these spheres. In modern conditions education involves an extensive use of information technology, which can most efficiently be implemented through e-learning [4]. It is now the most important element of distance learning [5, 6]. Distance education technologies are applied in both traditional (full-time), and a remote (correspondence) training at various levels of education [7, 8]. The issues of distant education potential are featured by scholars from different countries [9-13].

It is also necessary to have a clear idea of the scale and the strategy of university education development where it is important for each student, teacher, and research staff member to not only obtain knowledge and professional competence in their fields, but also to participate more actively in the activity of various research and production and technology sites and the transfer of modern technologies [14]. This forms the basis of implementing modern educational technologies, of the methodology of research and development, of experiments, and of working with students [15, 16].
In the KFU experience, the main technology sites are the university’s laboratories, oil areas, pilot factories, vocational schools, "the Children’s University", early professional orientation of schoolchildren, engineering centres, and centres of training and retraining of teaching staff in the education system [17].

2. MATERIALS AND METHOD

KFU (before known as the Kazan State University, KGU) was founded in 1804 under the decree of Tsar Alexander the First [18]. This was the third largest higher educational institution in Russia after the Petersburg (1725) and Moscow (1755) Universities. KGU kept this status throughout the whole history of the USSR and the contemporary history of Russia at the end of the 20th and the first decade of the 21st centuries.

The changes occurred in 2011-2012, especially since September 1, 2013, when, under the new Law "On Education in the Russian Federation", KGU received additional rights in organizing its research and development activity and personnel training (University 2.0 Model).

Upon becoming KFU and having research and development universities in Kazan, the university was granted the right to include specialized educational institutions, such as the former Kazan State Pedagogical University (KGPU), currently the Institute of Psychology and Education, the Naberezhnye Chelny KFU Engineering Centre, the Elabuga Institute of the Kazan Federal University, and some other educational institutions. This enriched its influence upon the society and the system of education within the country and in the Republic of Tatarstan.

As of the beginning of January, 2018, there are more than 43,900 students at the Kazan Federal University, 31,550 of which being students of full-time intramural form of study. 5,495 students from 94 countries are studying to become specialists in various areas. There are more than 33,000 students in the Bachelor Programs, more than 6,500 students in the Master Programs, 2,267 specialists and 1,233 postgraduate students; the staff includes 10,561 employees and 3,790 academic personnel, whose average age is 44 years. Such orientation towards a person makes it possible to successfully implement the most recent educational technologies, many of which are verified by Russian and foreign pedagogical experience.

Besides, 18 institutes and 2 vocational schools implement 589 study programs and 513 programs of additional training and their contents are constantly updated and improved. 726 real estate properties covering 885,000 sq. m are used for the implementation, as well as 97 land plots, which exceed 245 hectares. Thus, by the beginning of 2018, this has made it possible to fully implement the University Education 3.0 Model, which included projects related to the development of science, education and innovations.

Certainly, at the time where the higher educational institutions that later became a part of the KFU were reformed, in particular, the EI of the KFU (2011-2012) demonstrated good results of its work, the main being accumulation of the empirical and research experience, implementing and approbating the advanced, innovative educational technologies. The same trend included the methodology of research, in the center of which there were school education and higher education, additional education establishments and training of pedagogical personnel (teachers and instructors).

From now on, the strategy of developing and implementing innovations is realized in the "road map". It includes further training of students in bachelor and master programs for work with students of various ages (including students of secondary professional education), improving the qualifications of youth instructors, expanding the KFU’s possibilities in global
competition, implementing innovations and digital technologies in all spheres of students’ life and teachers’ work (transformation of the University 4.0 Model) to 2025.

Another specific feature of implementing educational technologies and improving the methodology of conducting research is the generalization of psychological and pedagogical and social experience of all participants in the educational and production process, implementation of the methods of training and education of the younger generation, training personnel for work in various types of educational establishments, and organization of work with people in out-of-school time.

This social contract of the society to a regional higher educational establishment, without doubt, influences the specific nature of scientific work of teachers and students. For example, this includes designing diagnostic devices on the basis of Russian-made and foreign-made toys [16], organizing subject-specific training of education specialists [19], implementing modern technologies in teaching physical and mathematical, power engineering, and other courses [20; 21], organizing work with gifted children, etc.

Of course, we cannot describe in a more subject-specific manner the content-related area of all the technological transformations of the university education (which also covers the activity of the EI of the KFU) without analyzing the infrastructure that is updated and improved annually. The infrastructure includes educational buildings, sports rooms, laboratories, offices, modern technical equipment, and students’ campuses and covers the everyday life of students and teachers, among others.

The most important area for the Mathematics and Natural Sciences Faculty is, without doubt, teaching physics, mathematics, information technologies, and energy & power engineering that are necessary for working with schoolchildren, students, teachers of educational establishments and of secondary professional educational establishment, as well as improving the quality of educational services and professional competencies of students and teachers. Here the methodology of scientific research and experiments covers all the most important areas of people’s life: the system of education, leisure activities, sports, quality of food, social life of students and teachers, as well as the sphere of their professional activity and interests.

Moreover, as a result of being oriented towards the world rankings (in which the KFU has lately started to occupy leading positions), the Elabuga Institute of the Kazan Federal University has compiled its top list of best faculties, chairs, students, and teachers that are updated on a quarterly and annual basis. These rankings include a lot of positions, for example, regarding students or young specialists, such as their active position in science, studies, sports, cultural and creative life, and social activity; the best are awarded at award ceremonies.

Certainly, the analysis of the activities of the EI would not be correct if we do not give the brief description of the activities of its main co-founder – the KFU. This is preconditioned by many factors, the most important being that prospective areas of developing modern educational technologies and implementing the newest concepts of the methodology of conducting experimental research are first of all realized in the activity of the federal university financed by the Government of the Russian Federation and the Republic of Tatarstan.

According to its Charter, the KFU includes several scientific and research, technical, and pedagogical institutes, multidisciplinary chairs, and 150 scientific laboratories located in Tatarstan where more than 3,000 academic employees work. The centre of the KFU is Kazan where 18 institutes and higher education schools, 3 independent faculties, 1 general university chair of physical education and sports, 2 specialized lyceums (the KFU IT lyceum and the
Lobachevsky Lyceum) for gifted children, the Volga Region Center for Advanced Training and Professional Retraining, and many other structural units work successfully. Here students are active participants and volunteers of such events and festivals as the XXVII Summer Universiade (2013), the 19th World Festival of Youth and Students (Sochi, 2017), the 2018 FIFA World Cup, etc.

Moreover, the KFU has maintained close ties to higher educational establishments and universities in our country and 313 universities and scientific centers from 60 countries.

It is but natural that the most important element (the content-related component of scientific and educational, social, and technological education programs) of innovative and digital transformations of the KFU is the Russian methodology that includes best achievements of the Russian academic science and of Russian and foreign scientists regarding formation of creative and self-developing person and development of market relations in Russia. This algorithm of work is described in detail in the "road map" of the KFU and all its structural units, covering various categories of citizens of Russia and several other countries, establishments, and enterprises.

The conditions for implementing the above in Tatarstan are improving constantly. These conditions include the system "kindergarten – school – higher educational establishment – secondary professional education" and the industrial sphere where more than 50 industrial production sites, 14 resource centres, IT-parks, the Alabuga Special Economic Zone, regional business incubators, and other structures function.

Currently the KFU's activity covers the whole territory of Tatarstan and influences the specialist training programs in the Republic of Crimea, the Middle East, republics of the Central Asia, China, and several other countries. Teachers and students actively study such activities of the largest countries as cultural activity, research, development, and production, humanitarian activities, technological, innovative and digital spheres, which is reflected in the "Strategy of Social and Economic Development of the Republic of Tatarstan till 2030" and in the transformation of the university model for 2018-2025.

3. RESULTS AND DISCUSSIONS

The trends of transformations are especially visible in the activity of the Elabuga Institute of the Kazan Federal University. During more than 65 years of work in the region, out institute (which before was a pedagogical institute since 1953 and pedagogical university since 1993) has accumulated vast experience of working with students, teachers, and instructors of additional professional education.

Currently, the EI of the KFU includes 7 faculties, 20 chairs, 20 scientific centres and centres of studies, laboratories, a search and reading room, a scientific library, an assembly hall, a great number of studying rooms equipped with modern educational means, 3 residence halls, 6 modern sports facilities, and the Burevestnik, the year-round sports and recreation camp.

More than 200 teachers work at full-time, part-time, and extramural departments that have more than 4,200 students. 70% of teachers have Candidate’s or Doctor’s degrees. The collaboration with more than 12 foreign universities is established.

This covers the activities of the whole university. The training of energy & power engineering specialists and industrial engineers is carried out by such structural units as the Mathematics and Natural Sciences Faculty, the Institute of Engineering, teachers of the Chair of Physics, the Chair of the General Engineering, the Chair of Mathematics and Applied IT Sciences and several others.
In Kazan, training of specialists is carried out according to the concept of distributed learning with the centre in the Institute of Psychology and Education, while in the EI of the KFU the training is carried out according to the classical scheme. The essence of it is the implementation of socially-oriented, scientific and research, and creative approach in working with the young, and the contents of the technical, natural science, humanities, and applied components is updated systematically.

Lately, the focus has been not only on implementing pedagogical innovations, but also on active implementation of digital technologies covering all categories (from children, school students, students, and professional workers to pensioners). The Institute of Silver Age is successfully working for the latter category, and the programs of computer education have great success.

Moreover, the current situation in education is such that one has to learn throughout their whole lives, every day, expanding one’s knowledge, skills, and professional competencies.

As shown by the experience, specialists who, beside their specialty, master several foreign languages, such as English, German, Chinese, and others, have more advantages in finding employment. Such training is successfully implemented at the EI of the KFU.

Besides, a future lawyer, economist, linguist, or even a biologist, process engineer, or a sports manager will need training in psychology and pedagogy or modern digital technologies. This allows young graduates to receive, together with a diploma of higher education, a lawful right to teach appropriate and adjacent disciplines in schools and colleges (secondary professional educational establishments), as well as allows graduates having the master’s degree or those who have completed post-graduate studies and have skills for scientific and research or production activity to find employment in higher educational establishments.

It is due to this reason that the EI of the KFU has lately started to implement new areas in the teaching process. One of those is additional training programs for students that include mental calculation, Turkish and Chinese, interior design, computer graphics, translation for professional interaction, legal work in state and municipal bodies, and corporate law.

Such additional education programs as special (speech pathology) education, psychological and pedagogical support to individuals with disabilities, finance and credit, preschool or elementary education, teacher of mathematics, teacher of technology, teacher of physics, computer science, and others are popular with students.

Currently such training is combined with creating profile competences, knowledge, and skills of students in pedagogical and production area, obtaining experience in research or social and economic sphere, and collaboration with Russian specialists and scientists in other countries. This allows the university education in Tatarstan and Russia to establish itself in the world, to develop knowledge intensive technologies, to actively implement digital technologies in training, education, and research process.

Moreover, the issues of teaching technical disciplines and humanities in at EI of the KFU are closely intertwined and intensified. This is shown, for example, in teaching Russian history, philosophy, professional pedagogy, psychology, Russian, and foreign languages together with the subjects of the physical and mathematical or energy engineering course in a higher educational establishment, or the activity of students’ unions.

This includes the following:

First, expanding the work with Russian and foreign students that involves teachers from various faculties, chairs, and laboratories, as well as gifted students who take active part in
arranging additional lessons of Russian, Tatar or foreign languages, scientific and technical subjects, including in energy & power engineering.

For example, by arranging lessons of various types (lectures, seminars, workshops) for students at the Mathematics and Natural Sciences Faculty, students are involved in systematic conducting of scientific and research projects, laboratory work, participation in scientific conferences, or carrying out pedagogical, scientific, or pre-diploma practical work. Such courses as Electrical Systems and Networks, Installation and Modification of Electrical Equipment of Enterprises and Civil Structures, Power Management of Electrical Supply and Electrical Energy Consumption Systems, and Computer and Information Technologies are covered here.

Besides, various aspects of students’ activities are implemented individually, under teachers’ supervision, taking into account students’ scientific interests, age, gender and social status, as well as requests of the Republic, which introduces required corrections in arranging the training process.

Second, the nature and content of working with gifted children, school students, students and their teachers is changed. In order to achieve this, several scientific training laboratories function all year round, in particular, laboratories of computer and mathematical simulation, such areas as obtaining a worker’s professions or skills of working with tools are developed. The activity of the Children’s University, the Summer Physical and Mathematical School, the InteLLeto Camp and many others is updated annually [16, 17].

This, of course, deeply influences the training of students taking bachelor’s or master’s degrees, the activity of young scientists, post-graduate students, graduates having candidate’s or doctor’s degrees, and other specialists. From now on, their activity covers the whole scientific and research cluster and the educational cluster of the Republic of Tatarstan and of all Russia, which reflects the demand of a person, the society, the state, the industry, the power industry, and reflects on the specific nature of scientific publications.

Third, the orientation towards creative development of a graduate’s personality where the depth of knowledge, practice-oriented and technological experience have special importance. Here individual (contact) work is combined with group (collective) forms covering the whole learning and instruction process, and the activity of students’ community manifests itself in involving all students in scientific and research, social and pedagogical, industrial and economic, and creative activities. From now on, all foreign students of the EI of the KFU are active participants or organizers of various national competitions, festivals, or sports competitions held in Russia and abroad.

That is precisely why future bachelors in energy & power engineering take active part in international examinations on various subjects, in city, republican, all-Russia, or international subject Olympiads, sports competitions, amateur art activities, or professional skills competitions.

Fourth, students and teachers start to gain excellence from the first year due to participating in scientific research related to power engineering, modern education and digital technologies.

In order to implement this, in the EI of the KFU such facilities as Evrika, a student design and engineering bureau, and PRO-techno and EcoTransport, scientific organizations, are organized and function. Those facilities implement various scientific ideas in programming or using small-sized robots (the RoboStart project) and an inter-university programme “Teacher of the 21st Century".
In training teachers of the new age, such projects as Teacher – Researcher, Creating an Environment for Developing Giftedness in an Educational Establishments, the International School Teacher Festival, and some others are implemented.

For the same purpose, the collaboration with Elabuga Automobile Works (the company manufacturing special-purpose machinery and equipment for oil and gas industry) and some other modern small- and medium-sized enterprises is established.

At last, future bachelors in energy & power engineering constantly expand their experience in interacting with specialists of the Alabuga Special Economic Zone who manufacture such import-substituting products as battery accumulators of various brands, sizes, and capacity, and with specialists of the Naberezhnye Chelny KFU Engineering Centre.

The period when this happens most often is the work experience internship when students learn about work of industrial robots, logistics, new production technologies, the scale of using modern machinery, and the possibilities of its implementation. Young people are inspired by work of directors of small-, medium-, and large-scale enterprises, under whose guidance people of Tatarstan work, and this example is just one of the many.

4. FINDINGS

The results of our research show that democratic, humanistic relations between students and teachers are best established on the basis of reorganizing the higher education area of universities’ activity (in particular, the EI of the KFU). Such relations form the personalities of young people and their advanced professional qualities.

The main factors of this establishment are as follows:

- variety of academic studies and types of students’ activities;
- developing scientific interests and professional competences of students, implementing innovations and digital technologies;
- forming vast expertise, knowledge, and skills; the need for the young to obtain two professions (at least two in intramural studies department);
- improving the physical and psychological health, the need to live a healthy life;
- Close ties between a university and the modern industrial facilities, technologies, Russian and foreign specialists, etc.

It is expected that the interaction of EI students and teachers with employees of the Alabuga Special Economic Zone expands, where hi-tech products are manufactured, new jobs are created, Russian and foreign specialists work, and the idea of involving the young in obtaining technical and power engineering professions or teachers’ retraining is implemented.

This is completely aligned with the concept of implementing the University 3.0 strategy that was successfully completed by the end of 2017 and gradual transfer to university education transformation (University 4.0) planned for 2018-2025.

The new concept (transformation) of the model of the KFU development as the base university provides for simultaneous development of science, education, technology transfer, active implementation of digital technologies, where the EI of the KFU takes active part. In order to achieve this, the university collaborates with the Nizhnekamskaya GES (Hydro-Electric Power Plant), the Kamsky Automobile Works (KamAZ), foreign residents of the Alabuga Special Economic Zone, the Naberezhnye Chelny KFU Engineering Centre, other Russian and foreign universities.

Everything is important – the activity of students and social structures of the universities, their personal example, creative way of life of the best country’s citizens, strengthening the
ties with the country’s teachers’ community, the administrative department of the head university, its structural units, specialists in various areas of knowledge, academic science, representatives of industrial and agricultural enterprises and social sphere.

5. CONCLUSION
Developing the potential of a humanities institute in training bachelors in energy & power engineering poses many questions, for example, how it is possible to train bachelors in energy & power engineering, specialists in digital technologies and pedagogical professions, having no power facilities, or why one of the tasks of the EI of KFU has been and still is to care about forming the creative personality of each student within the system of development and strengthening the market relations of the country.

Each university or institute has to implement scientific achievements in practice in parallel to training highly skilled personnel, and this imposes additional obligations on its staff. In this regard, mastering the advanced education, information, and production technologies is facilitated by conducting lessons in various areas of study in accordance with the curricula, organizing workshop sessions, lectures, and other forms of works involving Russian and foreign scientists.

As confirmed by our experience, the quality of such work improves greatly if students participate in arranging the exhibitions of pedagogical and technological achievements of the Republic of Tatarstan and Russia, and improve their cooperation with specialists of the Alabuga Special Economic Zone, the Naberezhnye Chelny KFU Engineering Centre, other Russian and foreign enterprises and universities.

This becomes possible when all participants in the pedagogical process, implementing innovations, strategic plans, and programs, including digital and computer resources, as well as the area of technology transfer, become active participants in the university education development strategy. This strategy has all the changes for success as the transformation of the university model started in 2011 (currently University 4.0) is planned for the next seven years, starting from 2018.

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